

# Package ‘TopicScore’

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**Title** The Topic SCORE Algorithm to Fit Topic Models

**Version** 0.0.1

**Description** Provides implementation of the “Topic SCORE” algorithm that is proposed by Tracy Ke and Minzhe Wang. The singular value decomposition step is optimized through the usage of svds() function in ‘RSpectra’ package, on a ‘dgRMatrix’ sparse matrix. Also provides a column-wise error measure in the word-topic matrix A, and an algorithm for recovering the topic-document matrix W given A and D based on quadratic programming.

The details about the techniques are explained in the paper “A new SVD approach to optimal topic estimation” by Tracy Ke and Minzhe Wang (2017) <arXiv:1704.07016>.

**Depends** R (>= 3.5.0)

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**LazyData** true

**RoxygenNote** 6.1.1

**Imports** utils, stats, graphics, RSpectra, combinat, quadprog, methods, Matrix, slam

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AP	<i>Associated Press data</i>
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**Description**

Associated Press data from the First Text Retrieval Conference (TREC-1) 1992, which has been processed by stop-words removal, low-frequency words removal and short documents removal.

**Usage**

```
data("AP")
```

**Format**

The data set is an object of class "simple\_triplet\_matrix" provided by package **slam**. It is a word-document matrix which contains the term frequency of 7000 words in 2134 documents.

**Source**

Harman, D. (1992, November). Overview of the First Text REtrieval Conference (TREC-1). In TREC (Vol. 1992, pp. 1-20).

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error_A	<i>The l<sub>1</sub> distance between two thin matrices up to a column permutation</i>
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**Description**

This function computes l<sub>1</sub> distance between two thin matrices up to a column permutation, that is to find the smallest sum of absolute value entry-wise difference between two matrices over all possible permutations over the columns of the first matrix. This can be done either universally or greedily.

**Usage**

```
error_A(A, A_hat, type = "u")
```

**Arguments**

A	The first p-by-K matrix.
A_hat	The second p-by-K matrix.
type	The search type for the best permutation. If it's 'u', the search is done universally, that is over all possible permutations of the columns of A. If it's 'g', the search is done greedily, that is at kth step find the closest column in the remaining columns of A to the kth column of A_hat in terms of l <sub>1</sub> distance. Greedy search may result in sub-optimal solutions, but it can be computed much faster than the universal way when K is large. The default value is 'u'.

**Value**

The  $l_1$  distance.

**Author(s)**

Minzhe Wang

**Examples**

```
# The example uses the runif() function in the 'stats' package
A <- matrix(runif(10*3),10,3)
A_hat <- A + 0.1*matrix(runif(10*3),10,3)
error_A(A, A_hat)
error_A(A, A_hat, type='g')
```

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simplex\_dist

*The  $l_2$  distance between a point and a simplex*

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**Description**

This function computes the  $l_2$  distance between a point and a simplex, that is the shortest  $l_2$  distance between the given point and any point in the simplex.

**Usage**

```
simplex_dist(theta, V)
```

**Arguments**

theta            A (K-1) dimensional vector, representing a point.  
V                The K-by-(K-1) vertices matrix, with each row being a vertex.

**Value**

The  $l_2$  distance.

**Author(s)**

Minzhe Wang

**References**

Ke, Z. T., & Wang, M. (2017). A new SVD approach to optimal topic estimation. arXiv preprint arXiv:1704.07016.

**Examples**

```
# Generate 3 vertices
V <- rbind(c(-1/2,-1/2), c(1,0), c(0,1))

theta <- c(3,1)
simplex_dist(theta, V)
```

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topic\_score

*The Topic SCORE algorithm*


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**Description**

This function obtains the word-topic matrix A from the word-document matrix X through the Topic SCORE algorithm.

**Usage**

```
topic_score(K, X, K0, m, Mquantile = 0, scatterplot = FALSE,
  num_restart = 1, seed = NULL)
```

**Arguments**

K	The number of topics.
X	The p-by-n word-document matrix, with each column being a distribution over a fixed set of vocabulary. This matrix can be of class <code>simple_triplet_matrix</code> defined in <b>slam</b> package, or any other class that can be transformed to class <code>dgRMatrix</code> defined in <b>Matrix</b> package through as function in <b>methods</b> package.
K0	The number of greedy search steps in vertex hunting. If the value is missing it will be set to <code>ceiling(1.5*K)</code> .
m	The number of centers in the kmeans step in vertex hunting. If the value is missing it will be set to <code>10*K</code> .
Mquantile	The percentage of the quantile of the diagonal entries of matrix M, which is used to upper truncate the diagonal entries of matrix M. When it's 0, it will degenerate the case when there is no normalization. When it's 1, it means there is no truncation. Default is 0.
scatterplot	Whether a scatterplot of rows of R will be generated.
num_restart	The number of random restart in the kmeans step in vertex hunting. Default is 1.
seed	The random seed. Default value is NULL.

**Value**

A list containing

**A\_hat** The estimated p-by-K word-topic matrix.

**R** The p-by-(K-1) left singular vector ratios matrix.

**V** The K-by-(K-1) vertices matrix, with each row being a vertex found through the vertex hunting algorithm in the simplex formed by the rows of R.

**Pi** The p-by-K convex combinations matrix, with each row being the convex combination coefficients of a row of R using V as vertices.

**theta** The K0-by-(K-1) matrix of K0 potential vertices found in the greedy step of the vertex hunting algorithm.

**Author(s)**

Minzhe Wang

**References**

Ke, Z. T., & Wang, M. (2017). A new SVD approach to optimal topic estimation. arXiv preprint arXiv:1704.07016.

**Examples**

```
data("AP")
K <- 3
tscore_obj <- topic_score(K, AP)

# Visualize the result
plot(tscore_obj$R[,1], tscore_obj$R[,2])
```

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vertices\_est

*The vertex hunting in the Topic SCORE algorithm*


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**Description**

This function conducts the vertex hunting in the Topic SCORE algorithm. More generally this function finds a simplex with K vertices that best approximates the given p data points in a (K-1) dimensional space.

**Usage**

```
vertices_est(R, K0, m, num_restart)
```

**Arguments**

R	The p-by-(K-1) data matrix, with each row being a data point.
K0	The number of greedy search steps.
m	The number of centers in the kmeans step.
num_restart	The number of random start in the kmeans step.

**Value**

A list containing

**V** The K-by-(K-1) vertices matrix, with each row being a vertex in the found simplex.

**theta** The K0-by-(K-1) matrix of potential K0 vertices found in the greedy step.

**Author(s)**

Minzhe Wang

**References**

Ke, Z. T., & Wang, M. (2017). A new SVD approach to optimal topic estimation. arXiv preprint arXiv:1704.07016.

**Examples**

```
# Generate 3 vertices
V <- rbind(c(-1/2,-1/2), c(1,0), c(0,1))

# Randomly generate the convex combination weights of 1000 points
Pi <- matrix(runif(3*1000),3,1000)
Pi <- apply(Pi, 2, function(x){x/sum(x)})

R <- t(Pi)%*%V
v_est_obj <- vertices_est(R, 1.5*3, 10*3, 1)

# Visualize the result
plot(R[,1], R[,2])
points(v_est_obj$V[,1], v_est_obj$V[,2], col=2, lwd=5)
```

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W\_from\_AD

*Estimation of W from A and X*

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**Description**

This function estimates the topic-document matrix  $W$  from the word-topic matrix  $A$  and the word-document  $X$  through quadratic programming.

**Usage**

```
W_from_AD(A, X)
```

**Arguments**

A	The p-by-K word-topic matrix.
X	The p-by-n word-document matrix.

**Value**

The estimated K-by-n topic-document matrix *W\_hat*.

**Author(s)**

Minzhe Wang

**Examples**

```
data("AP")
K <- 3
tscore_obj <- topic_score(K, AP)
W_hat <- W_from_AD(tscore_obj$A_hat, AP)
```

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